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The Economic and Environmental Effects of Eliminating the U.S. Tariff on Ethanol*

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Executive Summary

The U. S. ethanol industry has grown dramatically over the last ten years to be a major supplier of liquid fuels and an even larger user of corn. However, a tariff and subsidy give the domestic ethanol industry a substantial advantage over its major competitor, Brazil.

This thesis analyzes the effect of eliminating the tariff on imports of Brazilian ethanol and the subsequent economic and environmental effects. First, the paper provides a substantial review of the current state of ethanol production and a review of the literature to motivate and provide the necessary information for the analysis. This leads to a numerical assessment of the effect of eliminating the tariff on several key markets, including the U. S. ethanol market, the corn market, the Brazilian ethanol market, and the U. S. gasoline market. To provide intuition, the numerical analysis includes graphs to help demonstrate the changes in each market. The findings are that removing the tariff would increase U. S. welfare by $14 million, decrease greenhouse gases at a value of $36 million, and increase Brazilian welfare by $361 million, leading to a global welfare increase of $411 million. While the overall effect is positive but small, the redistributive effect of eliminating the tariff is large, with low-income groups gaining most. Despite the overall positive effect of eliminating the tariff, an analysis of the political economy indicates that the removal of the tariff is unlikely.

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I. Introduction

Ethanol is uniquely situated at the intersection of agriculture and energy. While energy and agriculture have always been linked, biofuels are tightening the link and creating new development challenges.[1] Ethanol has also recently found itself in the media spotlight, due to the rising price of energy and food as well as increasing international focus on climate change and poverty. Because ethanol is a major connection between contentious issues such as energy and agriculture, few political issues have been discussed with as much fervor as ethanol. [2] And few issues are discussed with such dissenting voices. Ethanol has received considerable praise from corn farmers, policymakers, automobile manufacturers and industry groups for purportedly being an environmentally friendly fuel that is grown domestically and revitalizes rural areas.[3,4] Others consider it to be a politically motivated environmental disaster that will threaten food security worldwide.[5,6] In any case, ethanol has captured the public's attention, and it deserves closer inspection to draw out its relative merits and shortcomings.

II. Background and History

A. Ethanol as a fuel or oxygenate

Ethanol can serve as either a liquid fuel (a replacement for gasoline) or as an oxygenate (a fuel additive, usually replacing MTBE). In the U. S., the majority of ethanol is used for the latter. In total, ethanol makes up approximately 3% of the fuel volume in the United States, and

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[1] Cassman, Kenneth G. Liska, Adam J. *Food and Fuel for all: realistic or foolish?* Biofuels, Bioproducts and Biorefining. 19 April, 2007.

[2] Naylor, Rosamond L. et al. *Ripple Effects of Crop-Based Biofuels on Global Food Security and the Environment.* Aug. 10, 2007.

[3] E85 Ethanol. General Motors Corporation. Available at http://www.gm.com/explore/fuel_economy/e85/index.jsp?deep=what. Accessed May 2008.

[4] Changing the Climate: Ethanol Industry Outlook 2008. Renewable Fuels Association Publication. February 2008. Accessed February 2008. Available at http://www.ethanolrfa.org/objects/pdf/outlook/RFA_Outlook_2008.pdf. Accessed March 2008.

[5] Runge, C. Ford. Senauer, Benjamin. 2007. *How Biofuels Could Starve the Poor*. Foreign Affairs. Available at http://www.foreignaffairs.org/20070501faessay86305/c-ford-runge-benjamin-senauer/how-biofuels-could-starve-the-poor.html. Accessed August 2007.

[6] Pimentel, David. *Ethanol Fuels: Energy Balance, Economics, and Environmental Impacts are Negative*. Natural Resources Research, Vol. 12, No. 2, June 2003. Available at http://www.ethanol-gec.org/netenergy/neypimentel.pdf. Accessed July 2007.

about half of gasoline contains some ethanol.[7] [8] Ethanol is predicted by the USDA to increase to 7.5% of the gasoline market in 2017. Unmodified engines can run with a mix of up to about 10-20% ethanol; after that, the engines need to be modified to avoid damage. Ethanol conventionally comes as E10, a mix of 10% ethanol and 90% gasoline. Some ethanol is also distributed as E85, a fuel mix of 85% ethanol and 15% gasoline, although the distribution system for E85 is underdeveloped.

Production of ethanol is dominated by Brazil and the United States, as seen in the chart below. China is a far distant third in ethanol production, and other nations trail far behind. In the U. S. more than 90% of biofuel production uses corn as the feedstock, although some is produced from agricultural or beverage waste, potatoes, or soy (in the form of biodiesel).[9] Brazil is similarly a monocrop biofuel producer, using sugarcane as the feedstock for more than 90% of production. European production uses rapeseed or other oilseeds to produce biodiesel, and Indonesia is a major producer of biodiesel from palm oil.

Table 1.
Worldwide historic ethanol production, 2004-2007 (Millions of gallons)

Country	2004	2005	2006	2007
U. S.	3,535	4,264	4,855	6,498.6
Brazil	3,989	4,227	4,491	5,019.2
China	964	1,004	1,017	486.0
Canada	61	61	153	211.3
European Union (France, UK, Spain, Germany, Poland, Italy, Sweden)	594	666	788	570.3

The ethanol industry in the U. S. grew an astounding 32% in 2007, far surpassing Brazilian production.[10] [11]

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[7]Changing the Climate: Ethanol Industry Outlook 2008. Renewable Fuels Association Publication. February 2008. Accessed February 2008. Available at http://www.ethanolrfa.org/objects/pdf/outlook/RFA_Outlook_2008.pdf. Accessed March 2008.

[8] Yacobucci, Brent D. Ethanol imports and the CBI. CRS Report for Congress. March 10, 2006. Read January 2008.

[9] Coyle, William. The Future of Biofuels: A Global Perspective. Amber Waves. November, 2007. Available at *http://www.ers.usda.gov/amberwaves/november07/features/biofuels.htm*. Accessed February 2008.

[10] Industry Statistics. Renewable Fuels Association. Accessed July 2007 Available at http://www.ethanolrfa.org/industry/statistics/#G

[11] Changing the Climate: Ethanol Industry Outlook 2008. Renewable Fuels Association Publication. February 2008. Available at http://www.ethanolrfa.org/objects/pdf/outlook/RFA_Outlook_2008.pdf. Accessed February 2008.

B. Trade Policy Regarding Ethanol

Brazil is one of two major world producers of biofuels and produces at much lower cost than the U. S. According to a Congressional Research Service Report, Brazilian production costs are 40% to 50% lower than in the U.S.[12] Additionally, studies have shown that Brazilian sugarcane-based ethanol has a much larger greenhouse gas reduction and energy yield than American corn-based ethanol. For these reasons, corn ethanol has been criticized and policy advocates have suggested that ethanol should be imported from Brazil rather than grown domestically. However, the U. S. subsidy and tariff put Brazilian ethanol at a substantial cost disadvantage with American corn-based ethanol and keep imports from Brazil to a trickle.

More than 188 million gallons of ethanol were imported from Brazil in 2007, equaling about 2.7% of total U. S. ethanol consumption. Brazilian imports form the lion's share of ethanol imports, which totaled 450 million gallons in 2007, about 6.4% of total consumption. There is especially high demand for Brazilians ethanol where the cost of transporting the ethanol from the Midwest is high and transporting it from Brazil is low (such as in coastal areas). [13] [14]

Table 2.
U.S. Fuel Ethanol Imports by Country (millions of gallons) [15]

Country	2002	2003	2004	2005	2006	2007 (up to Nov. 2007)
Brazil	0	0	90.3	31.2	433.7	188.8
Jamaica	29	39.3	36.6	36.3	66.8	75.2
El Salvador	4.5	14.7	25.4	33.4	25.9	73.3
Trinidad & Tobago	0	0	0	10.0	24.8	42.8
Costa Rica	12	14.7	25.4	33.4	35.9	39.4
Canada	n/a	n/a	n/a	n/a	n/a	5.3
China	n/a	n/a	n/a	n/a	n/a	1.4
Total	45.5	60.9	159.9	135.0	653.3	426.3

The RFA estimates total imports of ethanol into the United States at 450 million gallons.

The Caribbean Basin Initiative (CBI) is another way by which some ethanol is being imported to the United States. The CBI has become noteworthy because a portion of the ethanol

[12] Yacobucci, Brent D. CRS Report for Congress. Ethanol Imports and the Caribbean Basin Initiative. March 2006.
[13] Industry Statistics. Renewable Fuels Association. Available at http://www.ethanolrfa.org/industry/statistics/#G. Accessed July 2007.
[14] Yacobucci, Brent D. CRS Report for Congress. Ethanol Imports and the Caribbean Basin Initiative. March 2006.
[15] Changing the Climate: Ethanol Industry Outlook 2008. Renewable Fuels Association Publication. February 2008. Available at http://www.ethanolrfa.org/objects/pdf/outlook/RFA_Outlook_2008.pdf. Accessed February 2008.

produced there has origins in Brazil instead of the CBI countries. Duty-free status was granted to certain Caribbean countries, and ethanol can enter the United States without paying the tariff if it contains at least 50% local feedstocks. Hydrated ethanol is being imported to CBI countries from Brazil, where it is mixed with local ethanol to meet the 50% feedstock requirement. It is then exported to the U. S., duty-free, despite the fact that contains some Brazilian ethanol. Approximately 100 million gallons of ethanol entered the United States from CBI countries in 2005. Up to 7% of U. S. ethanol consumption may be supplied by Caribbean Basin countries, and currently only about 3% is coming from those countries.

C. Current policy

Domestic ethanol receives two forms of preferential treatment. The first is the 51 cent per gallon credit that is given to ethanol blenders, which effectively lowers the cost of ethanol by 51 cents per gallon. Interestingly, however, the forthcoming Farm Bill may lower that tax credit by 12 percent.[16] Many states also implement an additional subsidy to ethanol producers, and there is an additional nationwide 10 cent per gallon tax credit for small producers.[17] [18] The second form of preferential treatment is the tariff of 54 cents per gallon plus a 2.5% ad valorem tariff. Effectively, these two protectionist policies create a $1.10 advantage for domestic ethanol over imported ethanol. These policies have spurred production and are creating a corn-based ethanol industry in the United States. When these policies measures are totaled with other implicit and explicit subsidies, ethanol is estimated to receive a subsidy of between $6.3 and $8.7 billion per year.[19]

In addition to trade policy, mandates have also served to fuel expanded ethanol production. The Energy Independence and Security Act (EISA), signed by President Bush in December 2007, updated the Renewable Fuel Standard by requiring fuel producers to use 36 billion gallons of biofuels by 2022. 21 billion gallons of this standard will come from "advanced

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[16] Bush Will Veto U.S. Farm Bill: USDA Chief http://www.nytimes.com/reuters/washington/politics-farmbill-veto.html

[17] Energy Information Administration (EIA), Alternative Fuels Data Center, *United States (Federal) Incentives and Laws, available at* http://www.eere.energy.gov/afdc/progs/view_ind_fed.php/afdc/352/0

[18] Runge, C. Ford. Senauer, Benjamin. 2007. *How Biofuels Could Starve the Poor*. Foreign Affairs. Available at http://www.foreignaffairs.org/20070501faessay86305/c-ford-runge-benjamin-senauer/how-biofuels-could-starve-the-poor.html. Accessed August 2007.

[19] Koplow, Doug. Biofuels—At What Cost?: Government support for ethanol and biodiesel in the United States. Earth Track, Inc. October 2006.

biofuels", including 16 billion gallons from cellulosic ethanol.[20] Cellulosic ethanol production may be further spurred by a dollar-per-gallon credit in the forthcoming Farm Bill.[21] The mandates in the ESPA are a substantial increase from the previous Renewable Fuel Standard in the Energy Policy Act of 2005, which mandated that 7.5 billion gallons of biofuels be produced in the United States by 2012. In summary, policy is driving a massive expansion in ethanol industry, and policy support is likely to exist far into the future.

III. Ethanol's Effect on Agriculture and the Environment Under Current Usage

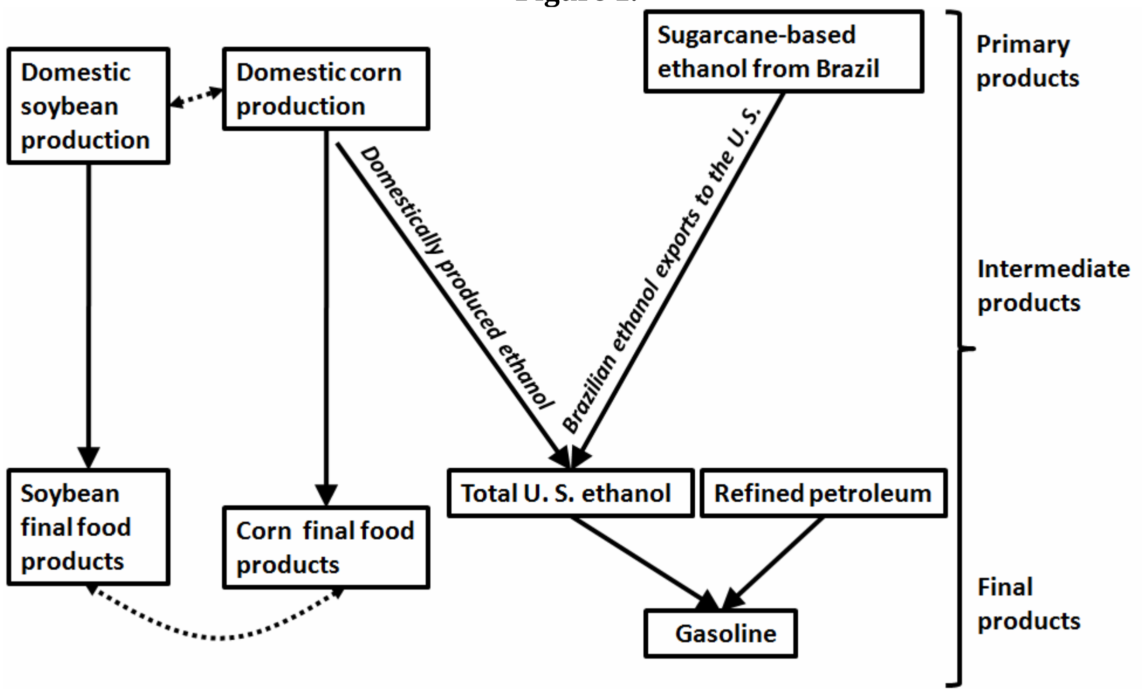
This section will describe the current state and history of ethanol, with a particular focus on agricultural markets and environmental effects. It will provide the necessary data and information on the current status of ethanol such that an analysis of eliminating the tariff can be conducted. The numerical analysis will build heavily on the data and information presented in this section. As the diagram below demonstrates, ethanol is inextricably linked to agriculture and food markets, as well as energy use. This section will provide an explanation of these interconnections in order to provide the information and contextual framework necessary for the quantitative analysis.

[20] Energy Independence and Security Act of 2007. Renewable Fuels, Consumer Protection, and Energy Efficiency Act of 2007 (Public Print). Library of Congress. Accessed December 2008.

[21] Bush Will Veto U.S. Farm Bill: USDA Chief http://www.nytimes.com/reuters/washington/politics-farmbill-veto.html

A. Connections between gasoline, ethanol, and agriculture

Figure 1.



Note: Solid lines indicate supply of product from one industry to another and dashed lines indicate interdependencies.

This diagram represents how the primary goods, intermediate goods, and final goods analyzed in this paper are connected. Corn and sugarcane are substitutes in producing ethanol in the United States. Corn and soybeans are substitutes, and both are inputs into final food products. Finally, ethanol and refined petroleum are both substitutes and complements in creating E10 or E85.

B. Corn in the United States

The United States is the world's largest producer of corn. Between 2003/2004 and 2005/2006, the United States produced 279.5 million metric tons of corn, about 41% of total global production. Corn is also a major recipient of agricultural subsidies, with corn's share of the $21 billion of total subsidies for agriculture in 2005 adding up to a whopping $8.9 billion.[22]

[22] Environmental Working Group, Farm Subsidy database.

[23] Additionally, the United States is a major player in the world corn market, historically accounting for 60-70% of global corn exports, which the USDA predicts will fall to 55-60% in the next several years. [24] Because the U. S. is such a major player, it has significant impact on global prices for corn. As demand patterns for corn change, American exports of corn are expected to decrease and foreign production are expected to increase. Additionally, less grain will be used for feed.[25] [26]

The fact that less corn will be directly available for feed is partially offset by the fact that one of the by-products of dry-mill ethanol production is distillers grain. Distillers grain can be used as livestock feed, although it is not a direct substitute for grain. Animal nutritionists recommend that only a small portion of animal feed be distillers grain. Distillers grain is a major by-product of ethanol production; for every 56 pounds of corn processed into ethanol, about 17.5 pounds (or wet equivalent) of distillers grain are produced. The production of dried distillers grain has increased substantially over the last several years in tandem with higher ethanol production.

Corn production in the United States has increased dramatically over the last ten years, at least partially as a response to increasing demand for corn from the ethanol industry. [27] As evidence of this point, the amount of corn used for ethanol has more than tripled in the last six years.[28] The U. S. Department of Agriculture's National Agricultural Statistics service reported that the 2007 corn crop would be the largest in U. S. history, and the greatest number of acres devoted to corn since 1944. Total corn production in 2007 was approximately 13.1 billion bushels, up from 10.5 billion bushels the previous year, with growers harvesting that corn from 85.4 million acres, up from 70.6 million acres the previous year. The USDA estimates that

[23] Runge, C. Ford. Senauer, Benjamin. 2007. *How Biofuels Could Starve the Poor*. Foreign Affairs. Accessed August 2007. Available at http://www.foreignaffairs.org/20070501faessay86305/c-ford-runge-benjamin-senauer/how-biofuels-could-starve-the-poor.html

[24] Hoffman, Linwood. Baker, Allen. Foreman, Linda. Young, C. Edwin. *Feed Grains Backgrounder.* United States Department of Agriculture. 2007. Available at http://www.ers.usda.gov/Publications/FDS/2007/03Mar/FDS07C01/fds07C01.pdf**.** Accessed July 2007. 17.

[25] Westcott, Paul C. *Ethanol Expansion in the United States: How Will the Corn Market Adjust?* United States Department of Agriculture. May 2007. Available at http://www.ers.usda.gov/Publications/FDS/2007/05May/FDS07D01/fds07D01.pdf. Accessed July 2007.

[26] Shapouri, Hosein. Gallagher, Paul. USDA's 2002 Ethanol Cost-of-production survey. United States Department of Agriculture, Office of the Chief Economist. July 2005. Available at http://www.usda.gov/oce/reports/energy/USDA_2002_ETHANOL.pdf. Accessed August 2007.

[27] Hoffman, Linwood. Baker, Allen. Foreman, Linda. Young, C. Edwin. *Feed Grains Backgrounder.* Page 16.United States Department of Agriculture. 2007. Available at http://www.ers.usda.gov/Publications/FDS/2007/03Mar/FDS07C01/fds07C01.pdf. Accessed July 2007.

[28] Ibid.

another 11.4 million acres will be needed to produce corn to satisfy ethanol production by 2010/2011.[29] Plantings are only expected to increase, with much of the land coming from soybeans.

Ethanol consumed 14% of corn plantings in 2005/2006, and about 18% of the crop in 2007 (approximately 2.3 billion bushels).[30] The percentage of the corn harvest used for ethanol is increasing despite the fact that yields are increasing and more land is being planted with corn. Ethanol has been the fastest growing use of U. S. in the U. S. In 2005/2006, 14% of the U. S. corn crop was used in ethanol production. Although the USDA previously predicted that this share would rise to 31% in 2016/2017, it appears that the 31% benchmark will be met as early as 2008/2009.[31] [32] Using the entire 2007 corn harvest in the U. S. would have made about 31 billion gallons of ethanol—less than a quarter of U. S. gasoline consumption. Increased yields are unlikely to counterbalance increasing demand for corn, as corn yields have been increasing by about 2% per year over the last decade. Corn yields in 2007 were the second highest in U. S. history, up to 152.8 bushels per acre from 149.1 bushels per acre several years ago.

One of the most important ways in which eliminating the tariff will affect domestic and global welfare is through the price of corn. Because the U. S. is such a major player in the world corn market, and because so much of the U. S. corn crop is going to corn, the tariff would decrease U. S. ethanol production and therefore decrease the price of corn. Given the U. S.'s effect on the world markets, and that prices for corn are so closely linked to the price of soy, rice, and wheat, the elimination of the tariff will have profound impacts for international food markets.

C. Ethanol's effect on food security

Ethanol has received significant criticism for its contribution to rising food costs. Food prices to consumers in the U. S. rose about 4.3% in the 12 months proceeding November 2007, faster than the general CPI. It is difficult to determine what portion of those rising prices are attributable directly to ethanol, but certainly at least some portion of the increase in prices are

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[29] Ibid.
[30] Changing the Climate: Ethanol Industry Outlook 2008. Renewable Fuels Association Publication. February 2008. Available at http://www.ethanolrfa.org/objects/pdf/outlook/RFA_Outlook_2008.pdf. Accessed February 2008.
[31] USDA, Agricultural Projections to 2016, February 2007
[32] Glauber, Joseph. 2008 Agricultural Outlook Forum: PROSPECTS FOR THE U.S. FARM ECONOMY IN 2008. February 21, 2008. USDA

ethanol-related. The prices of staple crops like wheat, corn, and soybeans have all increased substantially over the last several years, simultaneous with increasing ethanol production. In developed countries, the cost of final food products has not risen as much as the price of crops, because "farm values" are only 19% of food costs. However, those that eat less processed foods, including many people in developing countries, more directly see the increase in costs.[33] Famously, the price of tortillas in Mexico nearly doubled over the last several years, leading to protests in that county. Rice prices in Asia have also been extremely high, threatening food security and increasing hunger.

While rising prices for corn and substitutes seem inevitable, the question is what effect rising prices will have on equity.[34] Those higher prices are certainly an opportunity for higher incomes for agricultural producers in the developing world, although net importers or consumers of food will suffer. According to a 2001 World Bank study, 2.7 billion people live on less than $2 day, with most of their income going to food. While some developing country producers will be able to take advantage of rising prices, most poor people in developing countries are net purchasers of food.[35] To make matters worse, the United States sends less food aid abroad when prices are high. [36] [37] Although there will be significant heterogeneity in the effects of higher food prices, consumption patterns indicate that the poorest will consume fewer calories.

D. Environmental effects of corn-based ethanol

Until the inclusion of land use changes, most studies of corn-based ethanol reported small to moderate decreases in greenhouse gas emissions relative to gasoline. The GREET model from the Argonne National Laboratory showed that corn ethanol could reduce GHG emissions by 18% to 28%.[38] A study by Farrell et. al estimated that the greenhouse emissions of corn based ethanol

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[33] Changing the Climate: Ethanol Industry Outlook 2008. Renewable Fuels Association Publication. February 2008. Available at http://www.ethanolrfa.org/objects/pdf/outlook/RFA_Outlook_2008.pdf. Accessed February 2008.
[34] Naylor, Rosamond L. *Ripple Effects of Crop-Based Biofuels on Global Food Security and the Environment.* Aug. 10, 2007.
[35] World Development Report 2008. 2007. The World Bank. Available at http://siteresources.worldbank.org/INTWDR2008/Resources/2795087-1192111580172/WDROver2008-ENG.pdf. Accessed May 2008.
[36] W. P. Falcon. "Whither Food Aid? A Comment," in P. Timmer, ed. *Agriculture and the State.* (Ithaca, New York: Cornell University Press, 1991): 237-246.
[37] 2006 FAO State of Food and Agriculture: Food Aid for Food Security. Food and Agriculture Organization of the United Nations. 2006. Available at: ftp://ftp.fao.org/docrep/fao/009/a0800e/a0800e.pdf. Accessed May 2008.
[38] Wang, M. Saricks, C. Santini, D. *Effects of Fuel Ethanol Use on Fuel-Cycle Energy And Greenhouse Gas Emissions.* Available at http://www.ipd.anl.gov/anlpubs/1999/02/31961.pdf. Accessed December 2007.

fell in the range of -36% to 29% below the emissions of conventional gasoline, with a point estimate of an 18% reduction.[39] A draft report by Mark A Delucchi that conducted a lifecycle analysis of biofuels found that a fuel with 90% corn ethanol led to a 2% reduction in greenhouse gas emissions relative to gasoline.[40] Most of these studies had wide ranges for potential reductions and cited differences in production techniques to explain the variation.

A study in Science by Searchinger et al. concludes that after including land use changes in other countries, corn ethanol has nearly double the lifecycle greenhouse gas emissions of gasoline.[41] A study by Fargione et al., also in Science, similarly found that when emissions from land use changes are included corn-based ethanol has a larger carbon footprint than gasoline.[42] These reports are the most recent as of May 2008, and although the debate lingers, corn-based ethanol is now considered to have negative greenhouse gas impact when land use changes are included.

E. Greenhouse gas effects of sugarcane-based ethanol

Given that Brazil is the world's second largest producer of ethanol and the largest exporter of ethanol, it seems likely that most of the additional imports to the U. S. after eliminating the tariff will come from Brazil. Understanding the Brazilian market, including its domestic supply curve, is essential for understanding the impact of eliminating the tariff on world ethanol markets. Further, the greenhouse gas emissions associated with both corn ethanol and sugarcane based ethanol are important to understand. Given that eliminating the tariff would be associated with lower consumption of corn based ethanol and greater consumption of sugarcane ethanol, it is important to understand the relative carbon footprints of the two sources of ethanol. The following two subsections will explore these issues.

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[39] Farrell, Alexander E. Plevin, Richard J. Turner, Brian T. Jones, Andrew D. O'Hare, Michael. Kammen, Daniel M. Kammen. *Ethanol Can Contribute to Energy and Environmental Goals.* Science, Vol. 311. January 2006. Available at http://rael.berkeley.edu/EBAMM/FarrellEthanolScience012706.pdf. Accessed December 2007.

[40]Deluchi, Mark. *Lifecycle Analyses of Biofuels [Draft Report]*. page 20, Institute for Transportation Studies, University of California, Davis. 2006. Access January, 2008 Available at. http://www.its.ucdavis.edu/publications/2006/UCD-ITS-RR-06-08.pdf. Accessed September 2007.

[41]Searchinger, Timothy. Heimlich, Ralph. Houghton, R. A. Dong, Fengixa. Elobeid, Amani. Fabiosa, Jacinto. Tokgoz, Simla. Hayes, Dermot. Yu, Tun-Hsiang. "Use of U.S. Croplands for Biofuels Increases Greenhouse Gases Through Emissions from Land Use Change." Science. Available at http://www.sciencemag.org/cgi/rapidpdf/1151861v1.pdf. Accessed February 2008.

[42] Fargione, Joseph. Hill, Jason. Tilman, David. Polasky, Stephen. Hawthorne, Peter. "Land Clearing and the Biofuel Carbon Debt." Science Express Report, February 2008. Available at http://www.sciencemag.org/cgi/rapidpdf/1152747v1.pdf. Accessed February 2008.

Brazilian sugarcane-based ethanol is generally considered to have reductions in greenhouse gas emissions relative to gasoline. Several lifecycle analyses of sugarcane ethanol have been conducted. A comprehensive study of greenhouse gas reduction from the production of sugarcane and ethanol in Brazil yielded a range of 2.82 kg of avoided CO_2 per *liter* of anhydrous ethanol and 1.97 kg of avoided CO_2 per *gallon* of hydrous ethanol. These numbers are relative to gasoline. The EIA reports that a liter of gasoline contains about 2.2 kg CO_2, although a gallon of ethanol only has about two thirds of the energy of a gallon of gasoline. Relative to gasoline, sugarcane based ethanol yields about an 80% net reduction in greenhouse gases as well as significant energy returns.[43] [44]

F. Land use effects in Brazil

Sugarcane itself is not cultivated on land that is particularly environmentally sensitive. Most sugarcane is grown in the Southeast of Brazil (especially in the São Paolo region) and in the Northeast. Cultivation is far away from the most environmentally sensitive lands, including the Amazon. However, an expansion of the amount of land cultivated for sugarcane, while not directly linked to deforestation, could raise the price of land and therefore encourage deforestation or push the agricultural frontier further into the Amazon. The greenhouse gas effects of deforestation could quickly offset any greenhouse gas reductions from biofuels. A "cascade effect" where increasing sugarcane production sends crops further north and eventually pushing production into deforested land seems inevitable—the question is the size of the effect. Because of land use changes, reductions in greenhouse for sugarcane ethanol relative to gasoline should be seen as lower bounds, since they do not incorporate the potentially substantial land use changes.

It is unclear whether sugarcane ethanol will directly or indirectly lead to large amounts of increased deforestation. Besides the fact that sugarcane is cultivated primarily in the Southeast and Northeast, away from the Amazon, it is also cultivated on a very small area of land. Since the advent of the Pro-Álcool program in 1975, the amount of sugarcane grown and the amount of

[43] Please note that this estimate does not include land use changes, which could be significant. Land use effects in Brazil are discussed in a subsequent section.
[44] Alckmin, Geraldo. Goldemberg, José. Macedo, Isaias de Carvalho. Leal, Manoel Regis Lima Verde. da Silva, João Eduardo Azevedo Ramos. *Assessment of greenhouse gas emissions in the production and use of fuel ethanol in Brazil.* Page 18. Government of the State of Sao Paolo. April 2004 Accessed August 2007

land cultivated by sugarcane have grown steadily. Today, sugarcane occupies only about 5.6 million hectares, or about 3% of total arable land in the country.[45] [46] Soybeans, at 20.7 million hectares, use more than three times as much land, and corn, at 13.6 million hectares, uses more than twice as much land as sugarcane. Sugarcane is therefore relatively small in land use compared to other crops.[47] In addition, only 54% of sugarcane is used to produce ethanol, the remaining amount used for producing sugar. Sugarcane growth represents a relatively small portion of total crop usage in Brazil, even though it is expected to expand to 9-11 million hectares over the next ten years.[48]

Additionally, there seems to be large areas of arable land in Brazil that are open to expansion. There are vast regions of grazing land that have relatively low value compared to sugarcane. The Brazilian Minister of Agriculture cited degraded pastureland as the area by which the sugarcane industry could expand by 3 million acres over the next 5 years. In Brazil, there are about 121 million hectares with a medium or high potential for sugarcane cultivation, which is comprised of grazing land and various crops. The Cerrado is a vast space about the size of Alaska that, although until recently thought to be barren, has been adapted to agriculture. In short, there seems to be possible regions for expansion of sugarcane that do not entail a direct or indirect increase in deforestation.

The bigger culprit of deforestation is soy, and soy prices are being driven higher partly through lower U. S. plantings. Higher prices for corn in the U. S. (partially from demand for ethanol) lead to increased corn plantings, on land that is often diverted from soybeans. In 2006, soybean plantings fell by 8 million acres, going primarily to increased corn production. [49] Due to decreased production and increased demand, the price of soybeans has increased over the last several years. Higher soy prices have been linked to deforestation and clear-cutting of the

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[45] Vades, Constanza. "*Ethanol Demand Driving the Expansion of Brazil's Sugar Industry*" June 4th, 2007. Available at http://www.ers.usda.gov/Briefing/Sugar/sugarpdf/EthanolDemandSSS249.pdf. Accessed July 2007.
[46] Goldemberg, José. *Ethanol for a Sustainable Energy Future.* 2007. Science 315, no. 5814. Available at http://www.sciencemag.org/cgi/reprint/315/5813/808.pdf. Accessed July 2007.
[47] Vades, Constanza. "*Ethanol Demand Driving the Expansion of Brazil's Sugar Industry*" June 4th, 2007. Available at http://www.ers.usda.gov/Briefing/Sugar/sugarpdf/EthanolDemandSSS249.pdf. Accessed July 2007.
[48] Naylor, Rosamond L. et al. *Ripple Effects of Crop-Based Biofuels on Global Food Security and the Environment.* Aug. 10, 2007.
[49] Westcott, Paul C. *Ethanol Expansion in the United States: How Will the Agricultural Sector Adjust?* Page 8. May 2007. United States Department of Agriculture. Available at http://www.ers.usda.gov/Publications/FDS/2007/05May/FDS07D01/fds07D01.pdf. Accessed July 2007.

Amazon.[50] To the degree that U. S. corn-based ethanol is responsible for higher soybean prices, corn ethanol is encouraging deforestation in Brazil. Eliminating the tariff would decreased domestic corn production, increase domestic soy production, and therefore lower the price of soy in Brazil, lessening deforestation.

IV. Analysis: Efficiency and Distributional Impacts of Eliminating the Tariff on Ethanol

A. Methodology and road map

This section provides a quantitative analysis of the effect of eliminating the tariff. The numerical analysis of eliminating the tariff on imported ethanol will consider the ethanol, corn, Brazilian ethanol, and gasoline markets.[51] A benefit cost analysis will be conducted in assessing the net benefits of removing the tariff as well as assessing the distributional impact on various groups. Additionally, non-market, environmental effects will be quantified. In order to provide intuition, the numerical analysis will contain a graphical component. The analysis will include a central case and also conduct a sensitivity analysis that accounts for a range of elasticities. A final section will discuss the impact of eliminating the tariff and discuss the political economy of current ethanol policy. It will attempt to explain the existence of the current ethanol policy, given that it is inefficient and inequitable. An analysis of the political institutions, stakeholders, and information asymmetries regarding ethanol will clarify why an inefficient policy exists regarding ethanol.[52]

B. Assumptions

In order to create a functioning and clear model given the complexity and uncertainty of ethanol, divergence from the real world is necessary. However, the thesis will outline those divergences and the assumptions of the model in the interest of understanding the limits of this

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[50] Morton, Douglas C. DeFries, Ruth S. Shimabukuro, Yosio E. Anderson, Liana O. Arai, Egidio. Bon Espirito-Santo, Fernando del. Freitas, Ramon. Morisette, Jeff. *Cropland expansion changes deforestation dynamics in the southern Brazilian Amazon.* Science. September, 2006. Available at http://www.pnas.org/cgi/content/abstract/103/39/14637?ijkey=96f5758bafa3b350c3e91ae2961c2c1ac0c42665&keytype2=tf_ipsecsha. Accessed May 2008.

[51] Tokgoz, Simla. Amani, Elobeid. *An Analysis of the Link between Ethanol, Energy, and Crop Markets.* November 2006. http://www.econ.iastate.edu/research/webpapers/paper_12691.pdf. Accessed November 2007.

[52] Calculations of change in consumer and producer surplus are done via linear approximation.

analysis. The assumptions are mentioned in reference to the market to which they refer, and are integrated throughout the analysis.

The one assumption that will be discussed before the analysis is the substitutability of ethanol and gasoline. It is assumed that an equal amount of gasoline energy and ethanol energy are perfect substitutes. In truth, while the price of ethanol and gasoline track, they are not perfect substitutes because ethanol also serves as an oxygenate in addition to being a fuel source. Because it is an oxygenate and because it is subject to different demand as part of the RFS, ethanol and gasoline are imperfect substitutes. Additionally, corn and sugarcane are highly regulated in both the United States and Brazil, such that the domestic price does not reflect the world price. Ethanol prices correlate much more closely with the price of the feedstock than the price of gasoline. Finally, E85 is not widely available and a small percentage of the American vehicle fleet can accommodate E85.

However, one could envision a situation in which ethanol and gasoline are perfect substitutes for each other. Once the oxygenate role for ethanol is completely filled, it will no longer have that additional added value. A nationwide flex-fuel vehicle fleet and well-integrated ethanol distribution system would make ethanol and gasoline near-perfect substitutes. In such a case, the price of ethanol would track gasoline at a price ratio equal to their energy ratios. In such a world, eliminating the tariff on ethanol would have no price effect, since the price of ethanol is dictated by the price of gasoline, which forms the great majority of the liquid fuels market in the U. S. While there would be no price effect of eliminating the tariff in such a situation, there would be a quantity effect, with a change in U. S. production as well as imports.

C. How prices of ethanol, agricultural inputs, and gasoline would change if the tariff were eliminated

This section offers a quantitative analysis of the effects of eliminating the tariff. The analysis yields numbers for a table, provided at the end of this section, with estimates of the gains and losses to various groups by eliminating the tariff. The results found in the analysis section are consistent with a similar analysis, conducted by Elobeid and Tokgoz of Iowa State University.[53] [54]After the summary table, a sensitivity analysis will be included.

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[53] Elobeid, Amani. Tokgoz, Simla *Removal of U.S. Ethanol Domestic and Trade Distortions: Impact on U.S. and Brazilian Ethanol Markets.* . 2006. Ames, Iowa: Center for Agricultural and Rural Development, Iowa State

The analysis follows the connections in Figure 1 in Section III, which indicated how ethanol was connected to various other goods and fuels. It starts with the ethanol market. This is the market that is most directly affected by the elimination of the tariff on imported ethanol, and other markets are derivative of this first market. After analyzing the primary effects on the ethanol market, the effects on secondary markets including corn, soybeans, Brazilian ethanol, and gasoline will be analyzed.

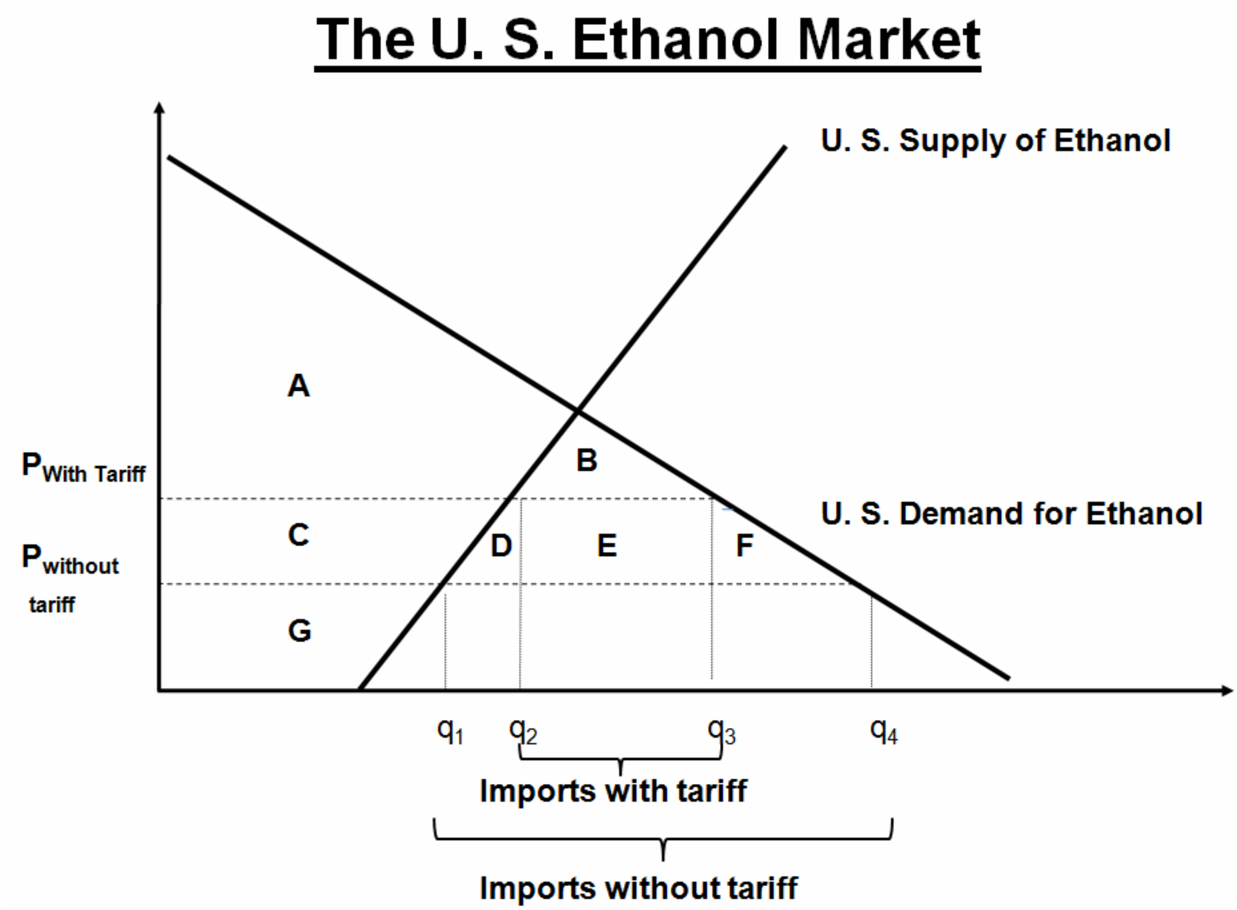
Since corn is an input into domestic ethanol production, decreased domestic ethanol production will mean less demand for corn.[55] The additional imported ethanol in the United States will lead to lower prices for gasoline.

University. Available at http://www.card.iastate.edu/publications/DBS/PDFFiles/06wp427.pdf. Accessed August 2007.

[54] Dr. Elobeid deserves a thanks for providing the elasticities used in her analysis. The central case elasticities are provided in an appendix at the end of this paper.

[55] The demand for ethanol assumes that the production will be sufficient to satisfy the Renewable Fuel Standard.

Figure 2. [56]



q_1	**6,214 million gallons of ethanol**
q_2	**6,498 million gallons of ethanol**
q_3	**6,948 million gallons of ethanol**
q_4	**7,155 million gallons of ethanol**
Price with tariff	**$2.58 per gallon**
Price without tariff (world price plus transportation)	**$2.41 per gallon**
Imports with tariff	**450 million gallons of ethanol**
Imports without tariff	**941 million gallons of ethanol**
Increase in imports by eliminating the tariff	**491 million gallons of ethanol**

In reference to the above diagram, the U. S. demand for ethanol includes the current 51 cent/gallon subsidy. The removal of the blender credit is not modeled, and is implicitly included in the demand function for ethanol. Also note that if the tariff were eliminated the price of Brazilian ethanol (and therefore the cost of imports) would increase.[57]

[56] Although in the graphical analysis the diagrams are drawn as lines in the interest of clarity and simplicity, they are actually curves.
[57] Price data for U. S. ethanol obtained from NYMEX for Chicago Ethanol Swap Prices for May 2008. Price data for U. S. ethanol obtained from São Paolo Bolsa de Mercadorias e Futuros for May 2008. Transportation costs are assumed to be 11 cents per gallon.

If the tariff were eliminated, U. S. production would fall from q_1 to q_2 and total U. S. consumption of ethanol would rise from q_3 to q_4. Imports would increase from the area between q_2 and q_3 to the area between q_1 and q_4, as shown on the graph above.[58]

Table 3.

	Initially	After Eliminating Tariff	Change
Consumer Surplus	A+B	A+B+C+D+E+F	C+D+E+F ($1,206 million)
Producer Surplus	C+G	G	-C (-$1,086 million)[59]
Tariff Revenue	E ($259 million)	- (0)	-E (-$105 million)

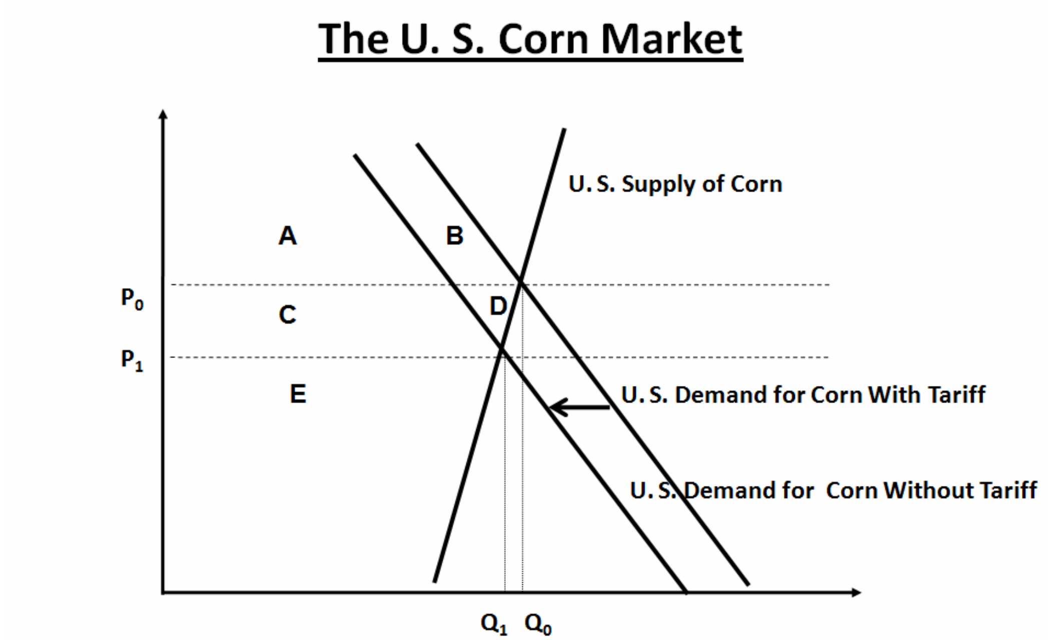
D. How would agricultural markets be affected by eliminating the tariff?

Eliminating the tariff affects several other markets beyond the ethanol market. Indeed, it can potentially influence almost every other market, through various direct and indirect effects. In this analysis we concentrate on the markets that are most directly affected. Because the effects are direct they are likely to be more significant than the impacts in other, indirectly related markets.

The first additional market considered is the corn market. The elimination of the tariff, by reducing ethanol's overall price, increases total ethanol consumption. However, as indicated by the figure above, the lower market price of ethanol implies a lower supply from domestic sources. Since corn is a key input into this supply, the demand for corn falls.

[58] The model considers a two-country world, with only the United States and Brazil. All of the U. S. imports come from Brazil (not an unreasonable assumption given that almost all of the imports to the U. S. are from Brazil or CBI countries). All of Brazil's exports that are not sent to the United States are considered Brazilian consumption.
[59] Throughout the analysis, losses of producer or consumer surplus are indicated by negative numbers.

Figure 3.[60]



Q_0	**13.1 billion bushels of corn**
Q_1	**13.0 billion bushels of corn**
Reduction in quantity	**100 million bushels of corn**
P_0	**\$6.14 per bushel**
P_1	**\$6.01 per bushel**
Reduction in price	**\$0.13 per bushel**

Table 4.

	Initially	After Eliminating Tariff	Change[61]
Surplus for Consumers of Corn Products	A+B	A+ C	C-B ($1,657 million)
Producer Surplus	C+D+E	E	-C-D (-$1,657 million)

Eliminating the tariff, as shown in the diagram above, lowers the demand for corn for ethanol. This decreases overall demand for corn.[62] [63] The quantity and price of corn supplied fall, and producers of corn lose the shaded area in producer surplus. All users of corn benefit from lower prices, including those that use corn for livestock feed, corn exporters, ethanol producers,

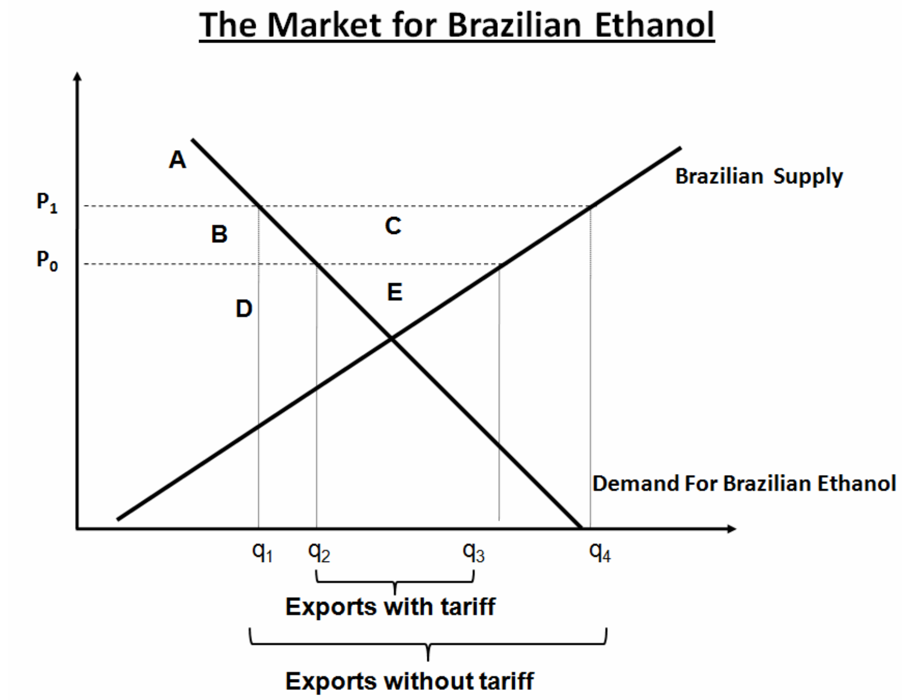
[60] The price of corn is obtained from the Chicago Board of Trade.
[61] Due to the difficulty in the asymptotic nature of the curve, area B is excluded from the calculations and gain to consumers is likely overestimated.
[62] When calculating reductions in demand for U. S. corn, dried distillers grain is considered to be equivalent to corn.
[63] The analysis does not include a world price for corn, but instead considers a closed economy model.

and other industrial and food uses. [64] Since land is necessary to produce corn, this graph should be approximately analogous to one demonstrating the price of cropland. Decreased demand for corn leads to decreased demand for cropland for corn.

While a complete analysis of the soybean market is not included in this thesis, the soybean market merits a discussion as part of the analysis of how eliminating the tariff on ethanol would affect agricultual markets. Soybeans are of particular interest not only because they are one of the major U. S. crops but also because high soybean prices have a direct effect on deforestation by soybean farmers in the Amazon, and therefore on global greenhouse gas emissions. Initially, a decrease in the demand for corn lowers prices and also lowers demand for soy, a substitute for corn. However, as less demand for corn leads to lower land prices, the marginal cost of soy production will fall. Additionally, increased demand for sugarcane based ethanol will reduce land available in Brazil for soybeans, leading to deforestation. Determining the relative size of these effects is crucial to determining the land use effects of the policy change.

[64] Given that feedstock costs are approximately 20% of the cost of a gallon of ethanol and a bushel is processed into 2.8 gallons of ethanol, a 13 cent/bushel price reduction would lead to about a 1 cent/gallon reduction in the cost of ethanol.

Figure 4.



q_1	**4,341 million gallons of ethanol**
q_2	**4,569 million gallons of ethanol**
q_3	**5,012 million gallons of ethanol**
q_4	**5,282 million gallons of ethanol**
Price with tariff	**$1.78 per gallon**
Price without tariff	**$2.30 per gallon**
Exports with tariff	**450 million gallons of ethanol**
Exports without tariff	**941 million gallons of ethanol**
Increase in exports by eliminating the tariff	**491 million gallons of ethanol**

Table 5.[65]

	Initially	After Eliminating Tariff	Change
Consumer Surplus (for Brazilians)	A+B	A	-B (-$2,312 million)
Producer Surplus	D+E	B+C+D+E	B+C(-$2,673 million)

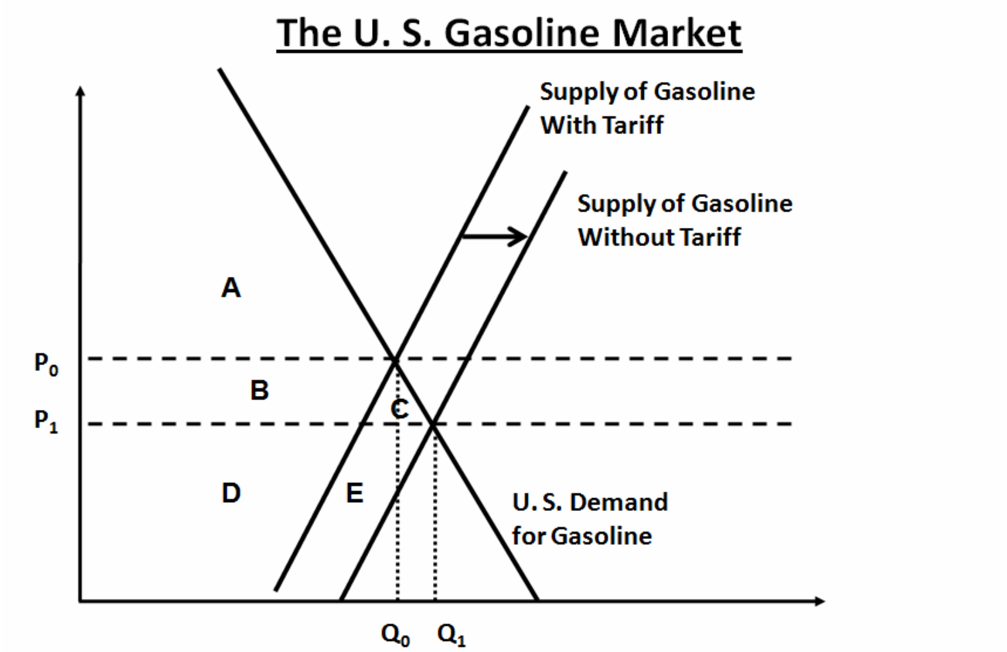
Increased demand from the U. S. increases both the price and quantity of ethanol supplied by Brazil. The law of one price dictates that the price of ethanol in Brazil and the United States

[65] It is assumed that the price in Brazil is the world price, given that it is the world's largest exporter.

should be equal, after accounting for transportation costs to the United States, given that they are identical final products.[66]

E. How eliminating the tariff would affect the gasoline market

Figure 5. [67]



Q_0	**140.00 billion gallons of gasoline equivalent**
Q_1	**140.14 billion gallons of gasoline equivalent**
Increase in quantity	**140 million gallons of gasoline equivalent**
P_0	**\$3.72 per gallon**
P_1	**\$3.63 per gallon**
Reduction in price	**\$0.09 per gallon**

Table 6. [68]

[66] Hoffman, Linwood. Baker, Allen. Foreman, Linda. Young, C. Edwin. *Feed Grains Backgrounder.* United States Department of Agriculture. 2007. Available at http://www.ers.usda.gov/Publications/FDS/2007/03Mar/FDS07C01/fds07C01.pdf. Accessed July 2007.

[67] It is assumed that additional imported ethanol is replacing domestic ethanol or gasoline, not MTBE. The thesis does not consider a change in policy regarding MTBE.

	Initially	After Eliminating Tariff	Change[69]
Consumer Surplus	A	A+ B+C	B+C ($12,021 million)
Producer Surplus	B+D	D+E	-B+E ($12,009 billion)

Providing more ethanol at a lower price in the United States leads to lower prices for gasoline in the United States, since ethanol can displace gasoline in blends of up to 10-20% or as E85 in flex-fuel vehicles.[70] In order to find how much the price of gasoline falls, the above number is calculated by finding the number of billions of gallons of gasoline equivalent with and without the tariff and the associated price decrease due to increased quantity.

F. The environmental effects of eliminating the tariff on ethanol

The most important environmental effect of eliminating the tariff is on greenhouse gases. Eliminating the tariff decreases corn-ethanol production and increases consumption of sugarcane-based ethanol. Overall, this should lead to lower greenhouse gas consumption since both corn ethanol and gasoline will be partially replaced by sugarcane ethanol, which has lower greenhouse gas emissions.[71] According to the central case calculations, 1.2 million tons of carbon dioxide emissions are avoided due to eliminating the tariff, and at $30/ton, that value is $36 million.

G. Summary of aggregate and distributional effects

The table below provides a tally and summary of the distributional effects throughout the analysis. The increase in U. S. welfare in calculated from the ethanol market, approximately equal to D and F on Figure 2. This net welfare increase for the U. S. is added to the value of decreased greenhouse gas emissions and finally to increase in social welfare in Brazil.

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[68] Price of gasoline obtained from EIA, as of May 12th 2008.
[69] Note that due to the shape of the curve and my method of linear approximation, it was difficult to estimate area E. Rather than give an imperfect measure, I have decided to exclude it from calculations and merely state that the loss is likely to be overstated.
[70] It is assumed that the U. S. has no monopsony power in the world gasoline market. Monopsony power would imply that as petroleum imports to the U. S. fall the price of those imports also fall.
[71] The thesis does not address the potential for cellulosic ethanol or advanced biofuels, but instead deals with corn-based and sugarcane-based ethanol. In general, the thesis does not take into account the possibility of technological change in the future.

Central case scenario

U. S. Market Effects	
U. S. ethanol consumers	$1.205 billion
U. S. ethanol producers	-$1.086 billion
U. S. corn consumers	$1.657 billion ($1,370 for non-ethanol uses of corn
U. S. corn producers	-$1.657 billion
Gasoline producers	-$12.002 billion
Gasoline consumers	$12.014 billion
Taxpayers (in lost tariff revenue) [72]	-$105 million
U. S. Subtotal	$14 million
Non-Market Effects	
Effect on greenhouse gas emissions	$36 million
U. S. Total	$50 million
Global Market Effects	
Brazilian ethanol consumers	-$2.312 billion
Brazilian Ethanol producers	$2.673 billion
Global Total	$411 million

The table below summarizes important numerical changes in the analysis.

Summary

Increase in imports	491 million gallons
Increase in Brazilian production	263 million gallons
Change in U. S. Price of ethanol	$0.17 reduction per gallon
Change in cost per bushel of corn	$0.13 per bushel reduction
Change in cost of gallon of gasoline	$0.09 cent per gallon reduction

The major net losers from the elimination of the tariff are corn producers, ethanol producers, and gasoline producers, as well as Brazilian consumers. Important to note in the results is that the overall improvement in net welfare from removing the tariff is small, but the redistributive effect is large.

H. Sensitivity analysis

Given the uncertainty in analyzing the ethanol market, this analysis includes a sensitivity analysis. In the sensitivity analysis, several key elasticities are varied and the results noted in the

[72] This calculation is derived from the number of gallons currently imported from non-CBI countries times the tariff.

following tables. The sensitivity analysis is useful to determine the relative importance of each elasticity, and the range of results around the central case.

Case A: Change the elasticity of demand for ethanol in the U. S. from -2.0 from -0.43.
Case B: Change the elasticity of supply for ethanol of 0.29 instead of 0.65.
Case C: Change the supply elasticity of corn to .7 from .265.
Case D: Change the elasticity of demand for Brazilian ethanol from -0.2 to -1.
Case E: Change the supply elasticity for Brazilian ethanol from .2 to 1.
Case F: Change the demand elasticity for gasoline from -0.043 to -0.2.

Aggregate and distributional effect

U. S. Market Effects	**Case A**	**Case B**	**Case C**	**Case D**	**Case E**	**Case F**
U. S. ethanol consumers (in billions)	$0.537	$1.594	$1,205	$2.325	$2.603	$1.205
U. S. ethanol producers (in billions)	-$0.482	-$1.442	-$1.086	-$2.023	-$2.245	-$1.086
U. S. corn consumers (in billions)	$0.726	$0.997	$0.631	$3.154	$3.520	$1.657
U. S. corn producers (in billions)	-$0.726	-$0.997	-$0.631	-$3.154	-$3.520	- $1.657
Gasoline producers (in billions)	-$24.061	-$15.981	-12.002	-$23.609	-$26.561	- $2.543
Gasoline consumers (in billions)	$24.109	$16.002	$12.014	$23.655	$26.619	$2.546
Taxpayers (in lost tariff revenue—in millions)	-$105	-$105	-$105	-$105	-$105	-$105
U. S. Subtotal (in millions)	-$50	$47	$14	$197	$253	$14
Non-Market Effects						
Effect on greenhouse gas emissions (in millions)	$13	$20	$36	$69	$36	$36
U. S. Total (in millions)	-$37	$67	$50	$266	$289	$50
Global Market Effects						
Brazilian ethanol consumers (in billions)	-$2.729	-$2.076	$2.673	$1.866	- $1.471	- $2.312
Brazilian Ethanol producers (in billions)	$3.181	$2.389	-$2.312	- $1.525	$1.795	$2.673
Global Total (in millions)	$415	$380	$411	$607	$613	$411

Summary

	Case A	**Case B**	**Case C**	**Case D**	**Case E**	**Case F**
Increase in imports (in millions of gallons)	545	447	491	957	1,076	491
Increase in Brazilian production (in millions of gallons	306	238	263	190	923	263
Change in U. S. Price of	$0.07	$0.22	$0.17	$0.32	$0.36	$0.17

ethanol (dollars reduction per gallon)						
Change in world price of ethanol (dollars increase per gallon)	$0.62	$0.47	$0.52	$0.37	$0.33	$0.52
Change in cost per bushel of corn (in dollars)	$0.06	$0.08	$0.05	$0.24	$0.27	$0.13
Change in cost per gallon of gasoline	$0.17	$0.11	$0.09	$0.17	$0.19	$0.02

V. Understanding the Political Economy of Ethanol Policy

A. Structures and institutions

This analysis has revealed that the tariff on ethanol is harmful from both a net welfare and environmental perspective. The question then arises—why does the tariff exist? The corollary to this question is equally important: what barriers exist to eliminating the tariff? In order to answer this question, one must understand the political economy of the ethanol tariff. Central to understanding the political economy is an understanding of the institutions that shape the political decisions surrounding ethanol. [73] As one of the most salient U. S. institutions, understanding the U. S. Congress will provide insight into such policies as the ethanol tariff exists.

The House allocates representatives based on population, but due to a compromise by the Founding Fathers, every state is represented by two senators in the U. S. senate. The result is that states with extremely small populations get a vastly magnified representation in the political process. This means that corn-producing states, which have lower than average population, are over-represented in Congress. Iowa alone produces at least 15% of the country's corn, and has 1/50th of the country's senators, and yet has only 1/100th of the country's population.[74] Iowa also has an ethanol production capacity of about 3.5 million gallons, about 26% of total capacity.[75] Therefore, Iowa's voice—in support of high prices for corn and continued pro-ethanol policies—

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73 Weingast, Barry R. Wittman, Donald A. "The Reach of Political Economy" in *The Oxford Handbook of Political Economy*, Forthcoming. Oxford University Press.

74 Hoffman, Linwood. Baker, Allen. Foreman, Linda. Young, C. Edwin. *Feed Grains Backgrounder.* United States Department of Agriculture. 2007. Available at http://www.ers.usda.gov/Publications/FDS/2007/03Mar/FDS07C01/fds07C01.pdf**.** Accessed July 2007.

75 Changing the Climate: Ethanol Industry Outlook 2008. Renewable Fuels Association Publication. February 2008. Available at http://www.ethanolrfa.org/objects/pdf/outlook/RFA_Outlook_2008.pdf. Accessed February 2008.

is sure to be heard. Further, Senator Harkin of Iowa is one of the most important and powerful shapers of agricultural policy in the U. S. – and he is sure to be do so in a way that reflects the interests of his constituents.

B. The Iowa caucus

The country's largest corn-producing state is also the testing ground for presidential candidates. Iowa is not only politically over-represented due to the structure of Congress, but it is also the first state to decide the political fate of presidential hopefuls. It would be political suicide to attempt to win the Iowa caucus with a platform that would lower incomes for corn farmers. Understanding the importance of the Iowa caucus, the presidential candidates shaped their policies accordingly. None of the candidates that made it out of the Iowa caucus were critical of ethanol.

A particularly revealing instance of the importance of the Iowa Caucus in shaping policy is that of John McCain's change in policies regarding ethanol. John McCain, the assumed Republican nominee in the 2008 election, had a stance that corn-based ethanol should not be protected with a tariff and that it was costly and environmentally harmful. In fact, he skipped the 2000 Iowa Caucus for related reasons, and was quoted in 2003 as saying, "ethanol is a product that would not exist if Congress didn't create an artificial market for it. Ethanol does nothing to reduce fuel consumption, nothing to increase our energy independence, nothing to improve air quality."[76] Before the 2008 Iowa Caucus, he dramatically shifted his tone and now is supportive of corn-based ethanol. Even straight-talking John McCain was forced to revise his previous statements to make his candidacy palatable to Iowans, demonstrating the political power of corn and ethanol.

C. Interest groups and Olsonian theory

Interest group theory can be used to explain the existence of a seemingly inefficient policy such as the ethanol tariff. In order to do so, this analysis will be informed by the theories of Mancur Olson, who posited that small, well-organized groups with significant potential gains

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[76] Birger, John. McCain flip-flops on ethanol on the Iowa Campaign Trail. CNN/Money. Available at http://money.cnn.com/magazines/fortune/fortune_archive/2006/11/13/8393132/index.htm. Accessed May 2008.

have a disproportionate affect on policy.[77] In the case of the ethanol tariff, there are several such groups that form a powerful coalition. Ethanol producers and corn farmers are two of the most powerful of these groups, but energy security and environmentally focused groups have also supported ethanol in the past.[78] The relative importance of these energy security “hawks” and environmental groups affects the strength of support for ethanol, but one can already see that disparate groups have similar interests with regards to keeping the ethanol tariff in place.

While many different interest groups have lobbied on behalf of ethanol, it would be difficult to overestimate the power of “King Corn” in the American political process. The Olsonian political mobilization bias is plain to see in the case of corn and ethanol. Corn growers are an extremely small subset of the American population, with significant benefits from the tariff, and are well-organized in trade organizations to lobby for preferable policy treatment. Major corporations such ADM and Cargill are also politically powerful groups with concentrated interests, and they spend heavily on lobbying. [79] While almost all Americans are affected by climate change, prices at the pump, and the cost of food, the cost per person of ethanol policies is small. The corn and ethanol lobby ethanol have large potential gains from favorable policy, whereas most Americans are not motivated to political action by the few extra cents they pay for corn flakes or gasoline. However, the users of corn, especially livestock producers, could potentially organize to counteract the tariff. As consumers are increasingly affected by higher prices for food and gasoline, they may also mobilize, especially if they perceive the negative effects of the tariff to be large.

VI. Other Considerations Regarding Ethanol

A. Equity

One important fact to draw from the numerical analysis is that the effect of eliminating the tariff is largely redistributive. While the impact on net welfare is small (largely due to very inelastic curves), and therefore might not provide much of an incentive for the government to eliminate the tariff, there are other important implications from redistribution. It’s important to

[77] Olson, Mancur. *The Logic of Collective Action: Public Goods and the Theory of Groups*. 1965. Harvard University Press

[78] Hahn, Robert W. Ethanol: Law, Economics, and Politics. American Enterprise Institute. AEI Center for Regulatory and Market Studies. January 2008.

[79] Stigler, George. *The Theory of Economic Regulation*. The University of Chicago.

note that most of the groups to who the tariff would redistribute (consumers of corn and gasoline, especially) are lower income. This is especially true given that the effect of the tariff would affect not only low-income groups in the U. S., but would also lower prices (however marginally) for gasoline and food worldwide. Brazilians also benefit overall from the elimination of the tariff, but their increase in welfare is not considered by U. S. policymakers.

VII. Discussion

It appears that for at least the time being, the U. S. tariff on imported ethanol will remain. It is unfortunate that corn-based ethanol is part of the problem rather than part of the solution in a time of increasing concern over the cost of energy, the changing climate, and on the impact of food prices on human welfare. The benefit to human welfare from eliminating the tariff is substantial, and the redistributive effect is large as well. However, even if the tariff were eliminated, it would form only an extremely small part of a broader energy solution. Even then, the small reduction in U. S. production due to eliminating the tariff is dwarfed by the double-digit annual growth in ethanol production. Eliminating the tariff is by no means a silver bullet and perhaps the most important message of this thesis is that while importing ethanol may have some benefits, it cannot be produced in an environmentally sound and socially beneficial way on the scale needed to solve the energy crisis.

Although the tariff on ethanol is harmful to social welfare, and unlikely to be eliminated, there are other areas in which there is opportunity for improving the environment. Simply increasing the efficiency with which electricity is produced and used could save a significant amount of energy. The use of more renewable energy sources, and cleaner burning fossil fuels like natural gas instead of coal, is also an important part of a multi-pronged approach to addressing climate change and reducing energy use. Another hopeful area is in promoting sustainable transportation planning and urban design, in order to minimize automobile use and make cities more walkable and transit-friendly. Additionally, the simplest (although perhaps least politically feasible) solution is simply to price all good to include their externalities.

VIII. <u>Conclusion</u>

This analysis has numerically quantified the effect of eliminating the tariff on imported ethanol. As demonstrated throughout the thesis, eliminating the tariff would have economic as well as environmental benefits for the United States. Brazilian ethanol could be imported at a lower cost than domestic ethanol, it would have less perverse effects on the cost of food, and it would lead to a reduction in greenhouse gases. The increase in social welfare to the United States is $14 million, with a value of greenhouse gas reductions of $36 million. When Brazilian effects are included, the total increase in social welfare is $411 million. However, while eliminating the tariff is a net gain for society as a whole, certain politically powerful interests such as corn farmers and ethanol producers would lose substantially as a result of eliminating the tariff (although low-income groups would benefit). Because the redistributive effects of eliminating the tariff are large relative to the increase in net welfare, and politically powerful groups would lose, political economy suggests the tariff is unlikely to be eliminated.

It is likely that "King Corn" will prevent the tariff from being eliminated and that ethanol will not be a solution to the energy problems facing the United States. Additionally, the Renewable Fuels Standard will be a major political force in ensuring that the domestic ethanol industry continues to grow, along with the VEETC. Rather than focusing on ethanol, energy efficiency, increase in renewable energy use, and an increased focus on transit-friendly and walkable cities are likely to be the most effective and most feasible ways to approach the ensure a sustainable and low-cost energy supply. Future research should focus on the potential role of cellulosic ethanol and advanced biofuels, as well as the potential for other countries in the developing world to become producers of biofuels.